Probing Electrical Conductivity Homogeneity Across a Boron-Doped Nanocrystalline Diamond Film Using Conductive Probe-Atomic Force Microscopy

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In recent years, boron-doped diamond thin film, grown using chemical vapor deposition (CVD) techniques, has been characterized and employed as an electrode material for electrochemistry. Much has been learned from electrochemical measurements about factors influencing their electrochemical activity, but they still possess some characteristics that are not fully understood. One property not fully understood is the electrical conductivity and what properties influence electron transfer across the diamond/solution electrified interface. Conductive probe-atomic force microscopy (CP-AFM) was used to map the topography and electrical conductivity of boron-doped diamond films, in particular, nanocrystalline films. The dependence of electrical conductivity on the boron doping level and bias voltage polarity were studied. Discontinuous conductive regions were observed on all films, with the fraction of conductive area increasing with the boron doping level. At the higher doping levels, the conductive regions exhibited metallic electronic properties. The results clearly show that diamond films are not uniformly conducting. They possess regions of high electrical conductivity isolated by regions of low conductivity. The results have important implications for the application of diamond in such fields as electrochemistry and field emission.

References:

[1] Swain, G.M., et al., "Electrochemical performance of diamond thin-film electrodes from different commercial sources", *Anal. Chem.,* **76**, 2553(2004).

[2] Holt, K.B., et al., "Scanning electrochemical microscopy and conductive probe atomic force microscopy studies of hydrogen-terminated boron-doped diamond electrodes with different doping levels", *J. Phys. Chem. B,* **108**, 15117(2004).